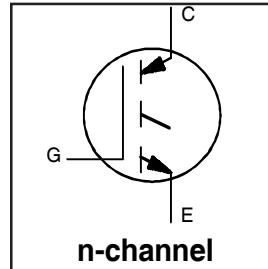


**INSULATED GATE BIPOLAR TRANSISTOR**

**Short Circuit Rated UltraFast IGBT**

**Features**

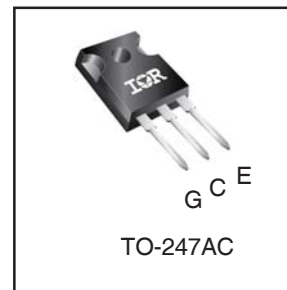
- High short circuit rating optimized for motor control,  $t_{sc} = 10\mu s$ , @360V  $V_{CE}$  (start),  $T_J = 125^\circ C$ ,  $V_{GE} = 15V$
- Combines low conduction losses with high switching speed
- Latest generation design provides tighter parameter distribution and higher efficiency than previous generations
- Lead-Free



$V_{CES} = 600V$
$V_{CE(on) typ.} = 1.84V$
@ $V_{GE} = 15V, I_C = 30A$

**Benefits**

- As a Freewheeling Diode we recommend our HEXFRED™ ultrafast, ultrasoft recovery diodes for minimum EMI / Noise and switching losses in the Diode and IGBT
- Latest generation 4 IGBTs offer highest power density motor controls possible
- This part replaces the IRGPC50K and IRGPC50M devices



Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRG4PC50KPbF	TO-247AC	Tube	25	IRG4PC50KPbF

**Absolute Maximum Ratings**

Parameter	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	52	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	30	
$I_{CM}$	Pulsed Collector Current ①	104	
$I_{LM}$	Clamped Inductive Load Current ②	104	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu s$
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$E_{ARV}$	Reverse Voltage Avalanche Energy ③	170	mJ
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	200	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	78	
$T_J$	Operating Junction and Storage Temperature Range	-55 to +150	$^\circ C$
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting torque, 6-32 or M3 screw.	10 lbf•in (1.1N•m)	

**Thermal Resistance**

Parameter	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	---	0.64	$^\circ C/W$
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.24	---	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	---	40	
Wt	Weight	6 (0.21)	---	g (oz)

**Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

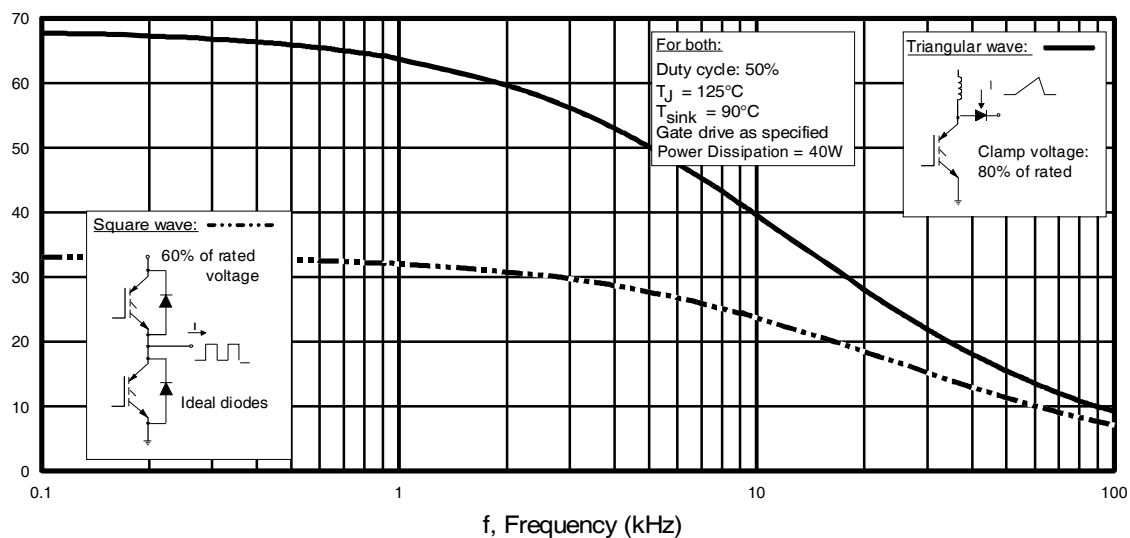
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
V <sub>(BR)ECS</sub>	Emitter-to-Collector Breakdown Voltage ④	18	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0A
ΔV <sub>(BR)CES/ΔT<sub>J</sub></sub>	Temperature Coeff. of Breakdown Voltage	—	0.47	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(ON)</sub>	Collector-to-Emitter Saturation Voltage	—	1.84	2.2	V	I <sub>C</sub> = 30A I <sub>C</sub> = 52A I <sub>C</sub> = 30A, T <sub>J</sub> = 150°C V <sub>GE</sub> = 15V See Fig.2, 5
		—	2.19	—		
		—	1.79	—		
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	—	6.0		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
ΔV <sub>GE(th)/ΔT<sub>J</sub></sub>	Temperature Coeff. of Threshold Voltage	—	-12	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance ⑤	17	24	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 30A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 25°C
		—	—	5000		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V

**Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

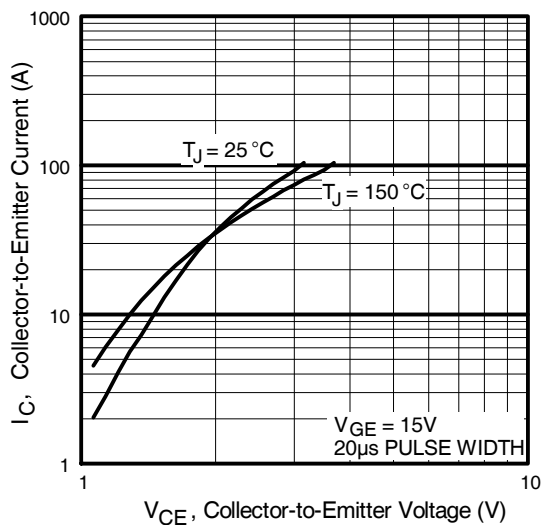
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	200	300	nC	I <sub>C</sub> = 30A V <sub>CC</sub> = 400V V <sub>GE</sub> = 15V See Fig.8
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	25	38		
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	85	130		
t <sub>d(on)</sub>	Turn-On Delay Time	—	38	—	ns	T <sub>J</sub> = 25°C I <sub>C</sub> = 30A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω
t <sub>r</sub>	Rise Time	—	34	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	160	240		
t <sub>f</sub>	Fall Time	—	79	120		
E <sub>on</sub>	Turn-On Switching Loss	—	0.49	—	mJ	Energy losses include "tail" See Fig. 9,10,14
E <sub>off</sub>	Turn-Off Switching Loss	—	0.68	—		
E <sub>ts</sub>	Total Switching Loss	—	1.12	1.4		
t <sub>sc</sub>	Short Circuit Withstand Time	10	—	—	μs	V <sub>CC</sub> = 400V, T <sub>J</sub> = 125°C V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω, V <sub>CPK</sub> < 500V
t <sub>d(on)</sub>	Turn-On Delay Time	—	37	—	ns	T <sub>J</sub> = 150°C, I <sub>C</sub> = 30A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω Energy losses include "tail" See Fig. 11,14
t <sub>r</sub>	Rise Time	—	35	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	260	—		
t <sub>f</sub>	Fall Time	—	170	—		
E <sub>ts</sub>	Total Switching Loss	—	2.34	—	mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	3200	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0MHz See Fig. 7
C <sub>oes</sub>	Output Capacitance	—	370	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	95	—		

**Notes:**

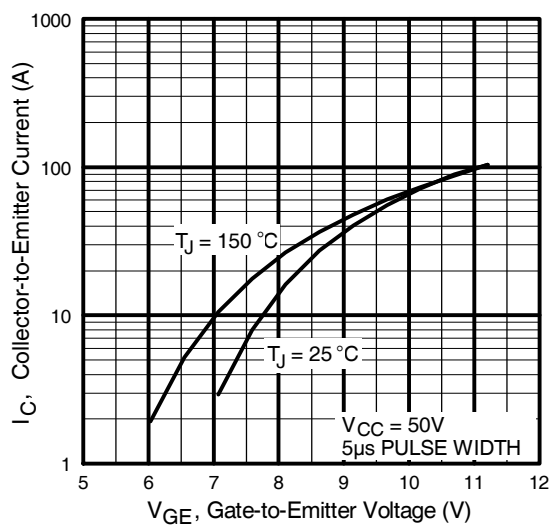
- |  |   |
|--|---|
| ① Repetitive rating; V <sub>GE</sub> = 20V, pulse width limited by max. junction temperature. ( See fig. 13b ) | ③ Repetitive rating; pulse width limited by maximum junction temperature. |
| ② V <sub>CC</sub> = 80%(V <sub>CES</sub> ), V <sub>GE</sub> = 20V, L = 10μH, R <sub>G</sub> = 5.0Ω             | ④ Pulse width ≤ 80μs; duty factor ≤ 0.1%.                                 |
|  | ⑤ Pulse width 5.0μs, single shot.   |



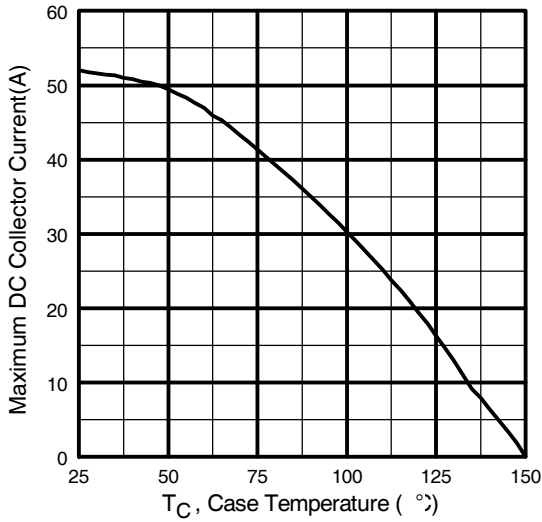
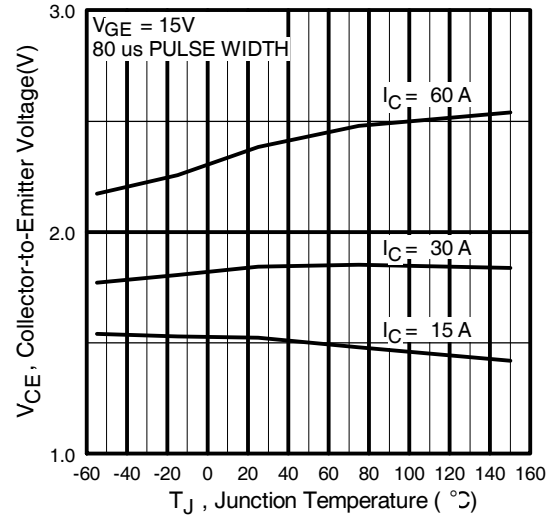
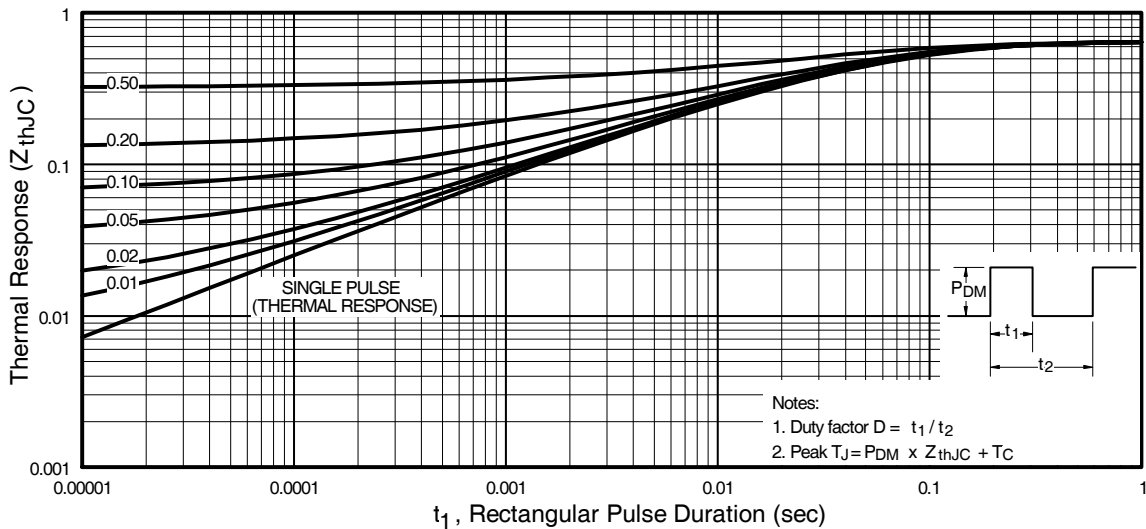
**Fig. 1 - Typical Load Current vs. Frequency**  
(Load Current =  $I_{RMS}$  of fundamental)

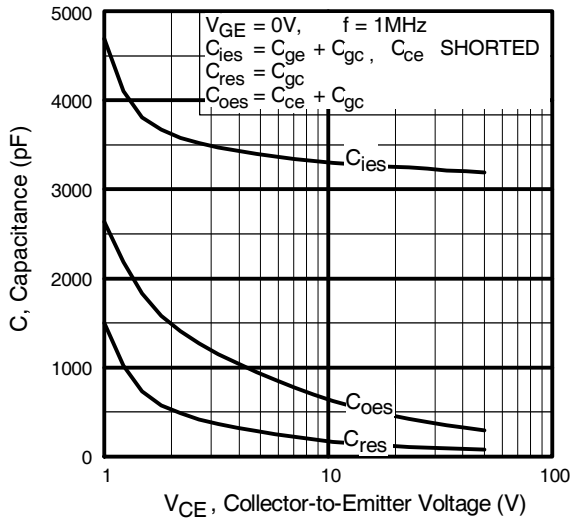


**Fig. 2 - Typical Output Characteristics**

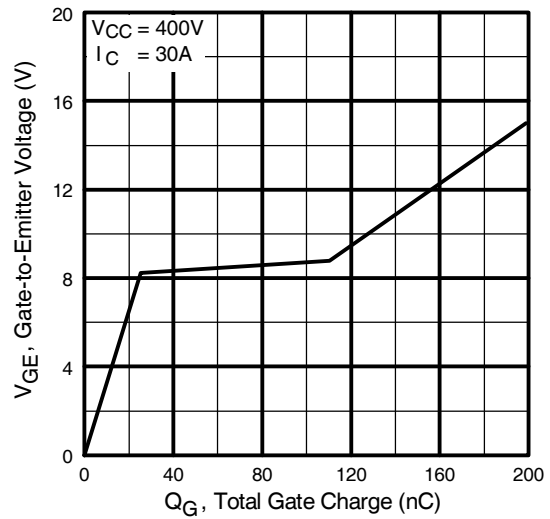


**Fig. 3 - Typical Transfer Characteristics**

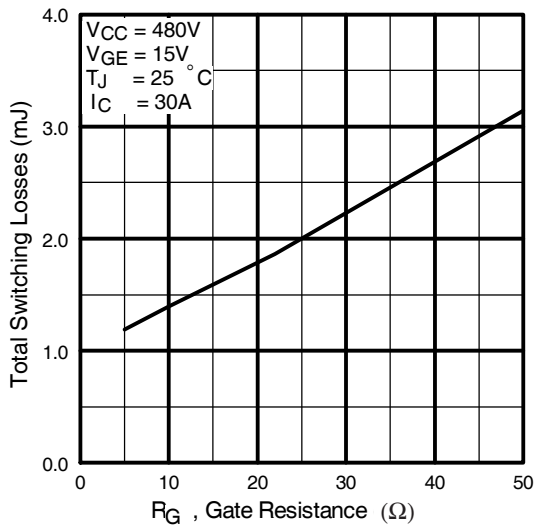

**Fig. 4 - Maximum Collector Current vs. Case Temperature**

**Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature**

**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**



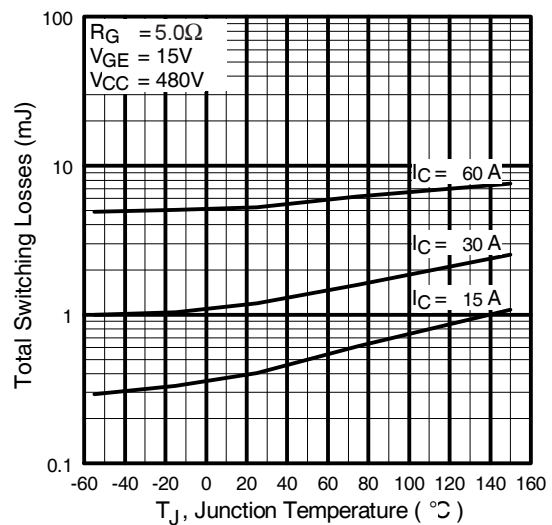
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



**Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage**



**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



**Fig. 10 - Typical Switching Losses vs. Junction Temperature**

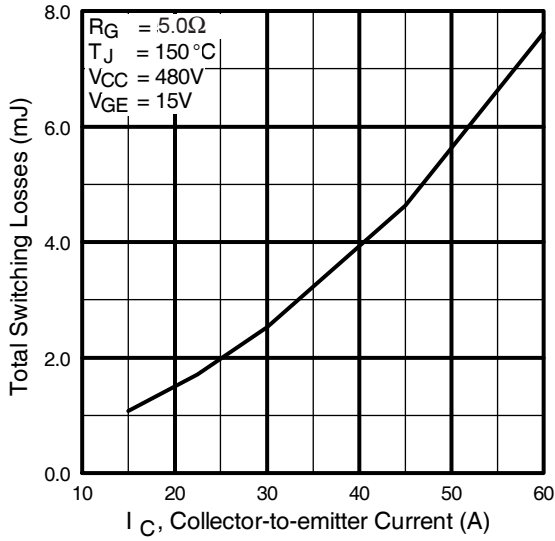


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

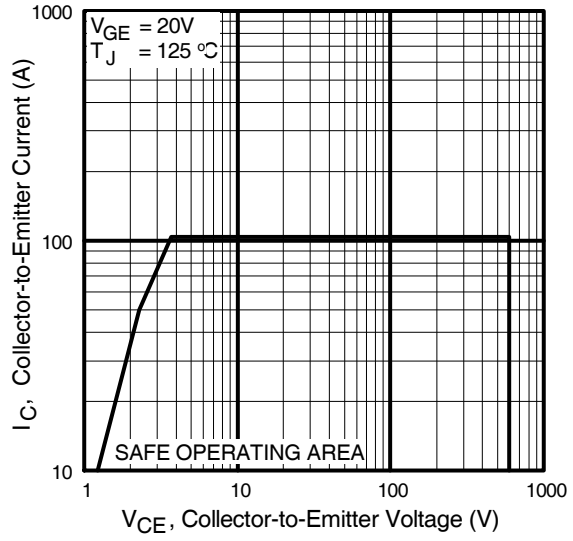
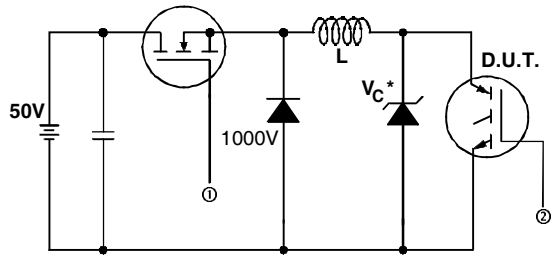
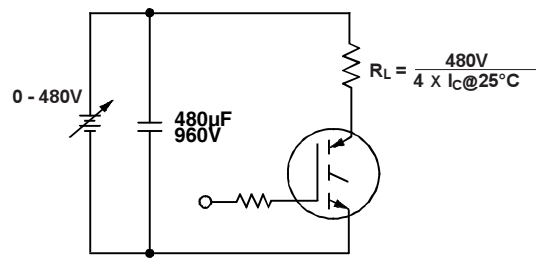


Fig. 12 - Turn-Off SOA

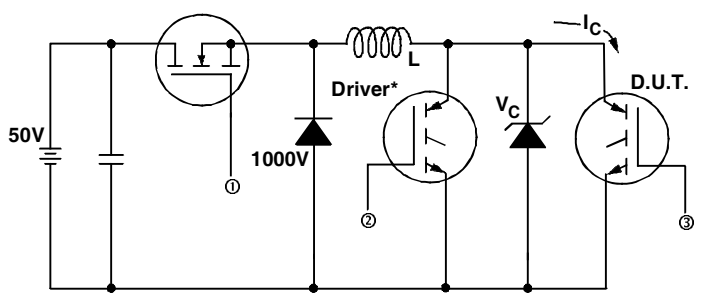


\* Driver same type as D.U.T.;  $V_c = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated  $I_d$ .

**Fig. 13a** - Clamped Inductive Load Test Circuit

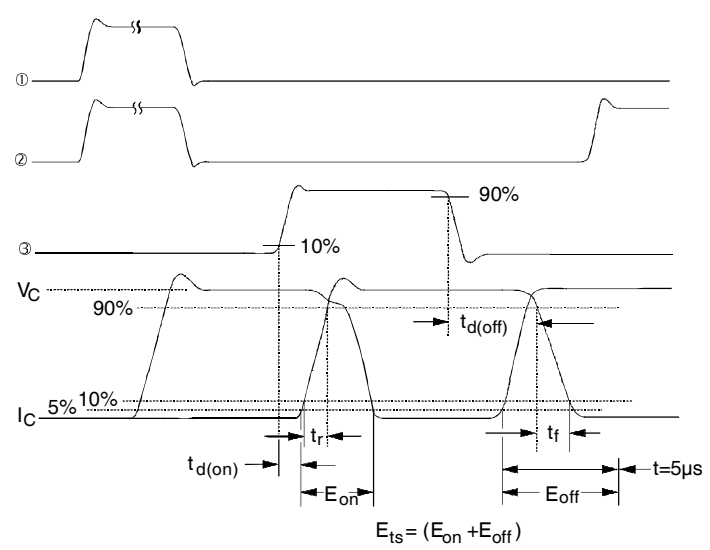


**Fig. 13b** - Pulsed Collector Current Test Circuit



**Fig. 14a** - Switching Loss Test Circuit

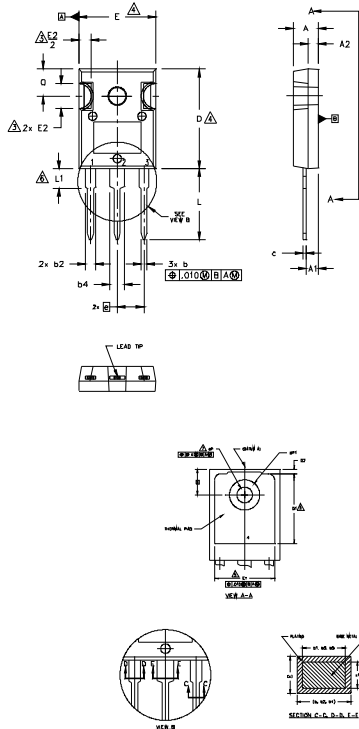
\* Driver same type as D.U.T.,  $V_C = 480V$



**Fig. 14b** - Switching Loss Waveforms

## TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



**NOTES:**

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
3. CONTOUR OF SLOT OPTIONAL.
4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7. ØP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AC .

SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
A1	.087	.102	2.21	2.59	
A2	.059	.098	1.50	2.49	
b	.039	.055	0.99	1.40	
b1	.039	.053	0.99	1.35	
b2	.065	.094	1.65	2.39	
b3	.065	.092	1.65	2.34	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.035	0.38	0.89	
c1	.015	.033	0.38	0.84	
D	.776	.815	19.71	20.70	4
D1	.515	-	13.08	-	5
D2	.020	.053	0.51	1.35	
E	.602	.625	15.29	15.87	4
E1	.530	-	13.46	-	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
ek	.010		0.25		
L	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
øP	.140	.144	3.56	3.66	
øP1	-	.291	-	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

**LEAD ASSIGNMENTS**

**HEXFET**

- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

**IGBTs, CoPACK**

- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

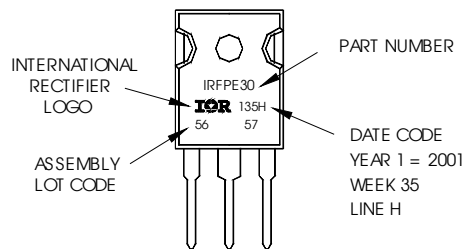
**DIODES**

- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

## TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFPE30  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2001  
IN THE ASSEMBLY LINE "H"

Note: "P" in assembly line position  
indicates "Lead-Free"



TO-247AC package is not recommended for Surface Mount Application.

Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>



**Qualification Information<sup>†</sup>**

<b>Qualification Level</b>	Industrial (per JEDEC JESD47F) <sup>††</sup>	
<b>Moisture Sensitivity Level</b>	TO-247AC	N/A
<b>RoHS Compliant</b>	Yes	

<sup>†</sup> Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/product-info/reliability>

<sup>††</sup> Applicable version of JEDEC standard at the time of product release

**Revision History**

<b>Date</b>	<b>Comments</b>
6/2/2015	<ul style="list-style-type: none"> <li>• Updated data sheet with corporate template.</li> <li>• Updated package outline on page 8.</li> <li>• Removed <math>I_{CES} = 2\mu A @ V_{CE} = 10V</math> on page 2.</li> </ul>

International  
 Rectifier

AN INFINEON TECHNOLOGIES COMPANY

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To contact International Rectifier, please visit <http://www.irf.com/whoto-call/>